MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIM 2 SESSION 2016/2017

ETM7126 – SATTELITE COMMUNICATIONS

10 MARCH 2017
8:00 P.M- 11:00 P.M
(3 Hours)

INSTRUCTION TO STUDENT

1. This examination paper consists of 7 pages including cover page with 4 Questions only.

2. Attempt **ALL** the questions. Each question carry equal marks and distribution of the marks for each question is given.

3. Please print all your answers in the Answer Booklet provided. Please number your answers clearly.

Question 1

(a) Describe how geosynchronous orbit operates in the satellite communication system.

[5 marks]

(b) Explain the two phases in launching a Geo-Satellite.

[5 marks]

(c) Molniya orbit is a highly elliptical orbit in satellite communication system, which named after a series of Soviet/Russian Molniya communications satellites. The orbital parameters for a Molniya orbit are listed in Table Q1(c) below.

Table Q1(c)

Period	11hours 58minutes 2seconds
Inclination	63.45°
Eccentricity	e
Apogee altitude	39105 km
Perigee altitude	A_p
Visibility duration	> 8 hours

(i) Calculate the length of semi major axis of the orbit, a.

[2 marks]

(ii) Determine the eccentricity, e and perigee altitude, A_p.

[4 marks]

(iii) Determine the mean true anomaly, M of a satellite on the Molnya orbit after 5 minutes the passage of perigee.

[2 marks]

(iv) List TWO(2) disadvantages of this orbit.

[2 marks]

(d) Determine the period and linear velocity the space shuttle with a circular orbit at the height, h of 1000 km.

[Take radius of the earth, r_{earth} of 6378 km, and gravitational parameter, $\mu = 3.986004418 \times 10^5 \text{ km}^3\text{s}^{-2}$]

[5 marks]

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Question 2

(a) List and describe THREE(3) sources of depolarisation.

[6 marks]

(b) The block diagram of a 12 GHz satellite uplink with the following parameter is shown in Figure 2(b). The transmitted power is 10 watts. The diameter of both the transmitting and receiving parabolic antennas is 3 m with an efficiency of 55%. The satellite is placed in a geostationary satellite orbit (GSO). [Take the distance of the GSO from the earth surface is 35 900 km].

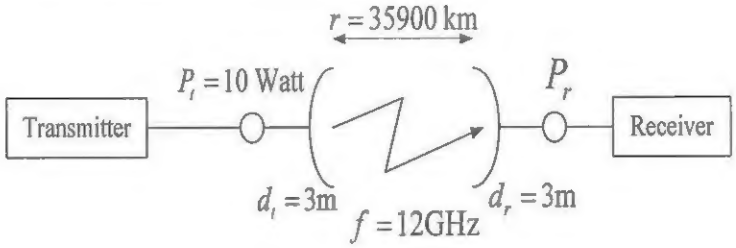

Figure 2(b)

Determine the following:

(i) Antenna gain in dBi.

[3 marks]

(ii) Effective isotropic radiated power (EIRP) in dBw.

[2 marks]

(iii) Free space loss in dB.

[2 marks]

(iv) Isotropic received power in dBw.

[2 marks]

(c) Figure 2(c) shows the satellite receiver noise system with specific parameters given for each device. The low noise amplifier (LNA) has a gain of 30 dB, and a noise figure of 4 dB. The LNA is connected to the downconverter through a 3 dB line loss cable. The downconverter has a gain of 10 dB and a noise figure of 10 dB. Finally the signal passes through an I.F. amplifier with a gain of 40 dB, and a noise figure of 20 dB. All the noise figures shown in the circuit are with effective temperature of 290 K.

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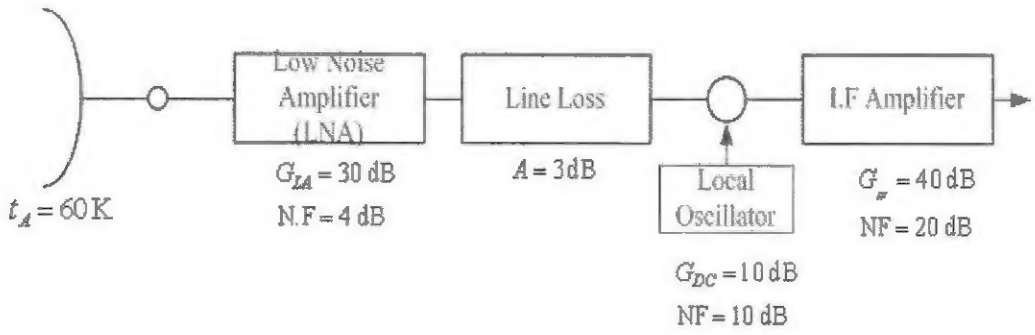

Figure 2(c)

(i) Construct an equivalent noise circuit to represent the receiver.

[2 marks]

(ii) Determine the total noise temperature and noise figure.

[6 marks]

(iii) Calculate noise power spectral density.

[2 marks]

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Question 3

(a) Explain with an aid of diagram, why it is necessary to employ single-sideband suppressed-carrier (SSB-SC) in a satellite communication system.

[6 marks]

(b) Give a reason why satellite packet switching is used in satellite system transmission.

[5 marks]

(c) In a special satellite packet switching (M/G/1 queue), given that an arrival rate, λ is 125 pps, average waiting time in the queue, W_q=0.002s and variance of the message length, σ^2 is 0.2. Determine the following;

(i) Service rate.

[1 mark]

(ii) Server utilization.

[1 mark]

(iii) Average message delay.

[3 marks]

(iv) Total message delay including satellite roundtrip delay, T_R of 2ms.

[2 marks]

(d) Consider a 70 channel frequency duplex multiplexing (FDM) system with a maximum baseband frequency of 252 kHz and a specified top channel SNR of 50 dB. Assume that FDM multichannel root mean square of frequency deviation, lf_r = 500 kHz is employed.

Determine:

(i) the bandwidth of the Frequency Duplex Multiplexing- Frequency Modulation-Frequency Division Multiple Access (FDM-FM-FDMA) carrier using Carson's Rule.

[2 marks]

Continued.....

(ii) the FDM multichannel loading factor of n=70 channels.

[2 marks]

(iii) the 0 dBm test tone rms frequency deviation.

[1 mark]

(iv) the Carrier to noise ratio of the FDM-FM-FDMA system in dB. Assume channel bandwidth of 3.1 kHz and psophometric weighting of 6.5 dB.

[2 marks]

Continued.....

Question 4

(a) Describe about interconnection between coverage areas by satellite beam scanning and draw a related diagram.

[6 marks]

(b) Describe the operating principle of very small antenna terminal (VSAT).

[5 marks]

(c) In satellite communication, there are several factors that affect the handover of satellite station. Suggest the handover types for each of the following scenarios.

- Scenario 1
  - Movement from one spot beam to another
  - mobile station still in the footprint of the satellite, but in another cell
- Scenario 2
  - Movement from one satellite to another satellite
  - mobile station leaves the footprint of one satellite
- Scenario 3
  - Movement from one gateway to another
  - mobile station still in the footprint of a satellite, but gateway leaves the footprint
- Scenario 4
  - Movement from the satellite network to a terrestrial cellular network
  - mobile station can reach a terrestrial network again which might be cheaper, has a lower latency.

[6 marks]

(d) Consider a multibeam satellite system with M spot beams. The total bandwidth B is divided into 4 subbands. Subband 1 is used 6 times, subband 2 is used 4 times, subband 3 is used 3 times and subband 4 is used 3 times. Calculate:

(i) the re-use factor if no orthogonal polarisation is used.

[2 marks]

(ii) the re-use factor if orthogonal polarisation is used.

[2 marks]

(iii) Comment on the results obtained above.

[4 marks]

End of Paper